



A Two-Radio Multi-cluster Link Layer Architecture for WINS NG 2.0

St. Petersburg, FL

April 17, 2001

Sensoria Corporation

Internetworking the Physical World





Link Layer Design Challenges



- Network assembly
 - Fast
 - Energy efficient
 - Robust
- MAC
 - Organize simultaneous transmissions by all nodes
 - Highly dependent on radio's capability
- Good delay/throughput characteristics
- SCALABLE!





Link Layer Topologies



- Single Hop
 - Interconnection length limits network size and scalability
- Single Cluster Centralized Organization
 - Yields the best delay/throughput tradeoff for small network sizes with high traffic
 - The star topology is not scalable
- Multi-Cluster Organization
 - Hierarchical topology
 - Scalable

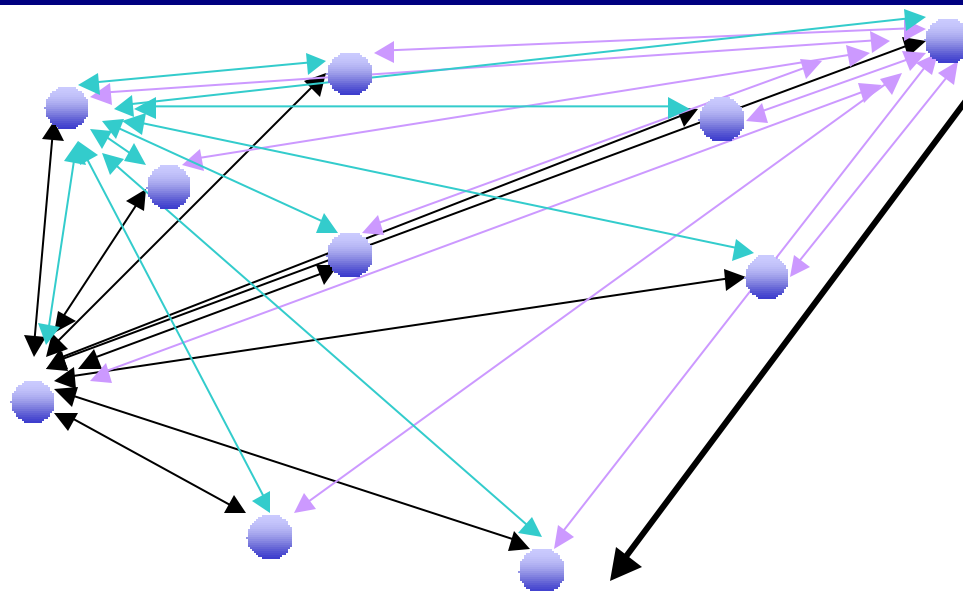




Single Hop



- No need to elect a controller
- No need to determine the underlying physical topology
- Suitable for small sized networks
- CSMA type MAC can be used (802.11 ad-hoc)
- Low to medium loads
- Not scalable



- Not energy friendly
 - requires continuous channel monitoring
 - As network size is increased larger transmit powers are needed

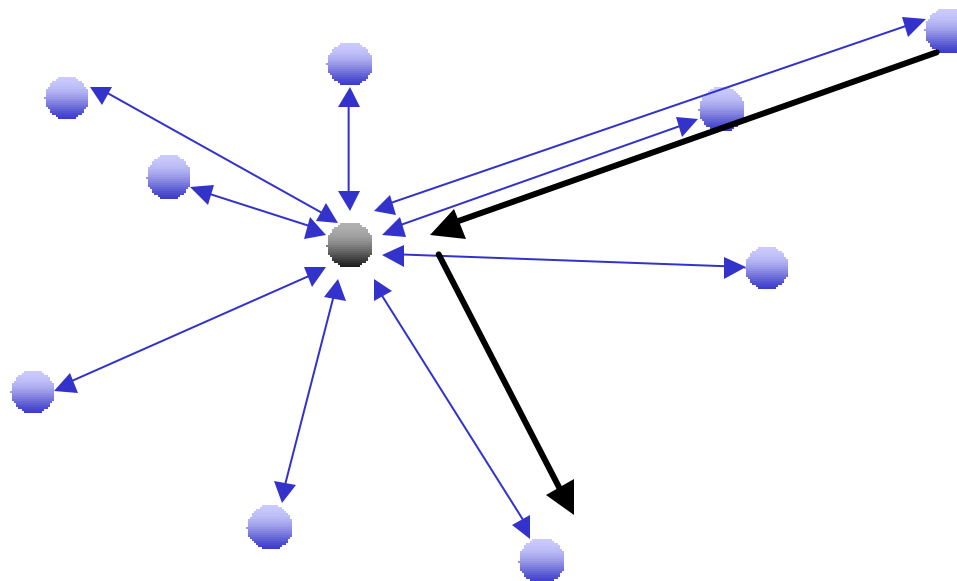




Single Cluster



- Controller must be assigned (elected)
- Physical connectivity must be determined
- No need to monitor the channel continuously (TDMA can be used)
- The base is the bottleneck
- Not scalable

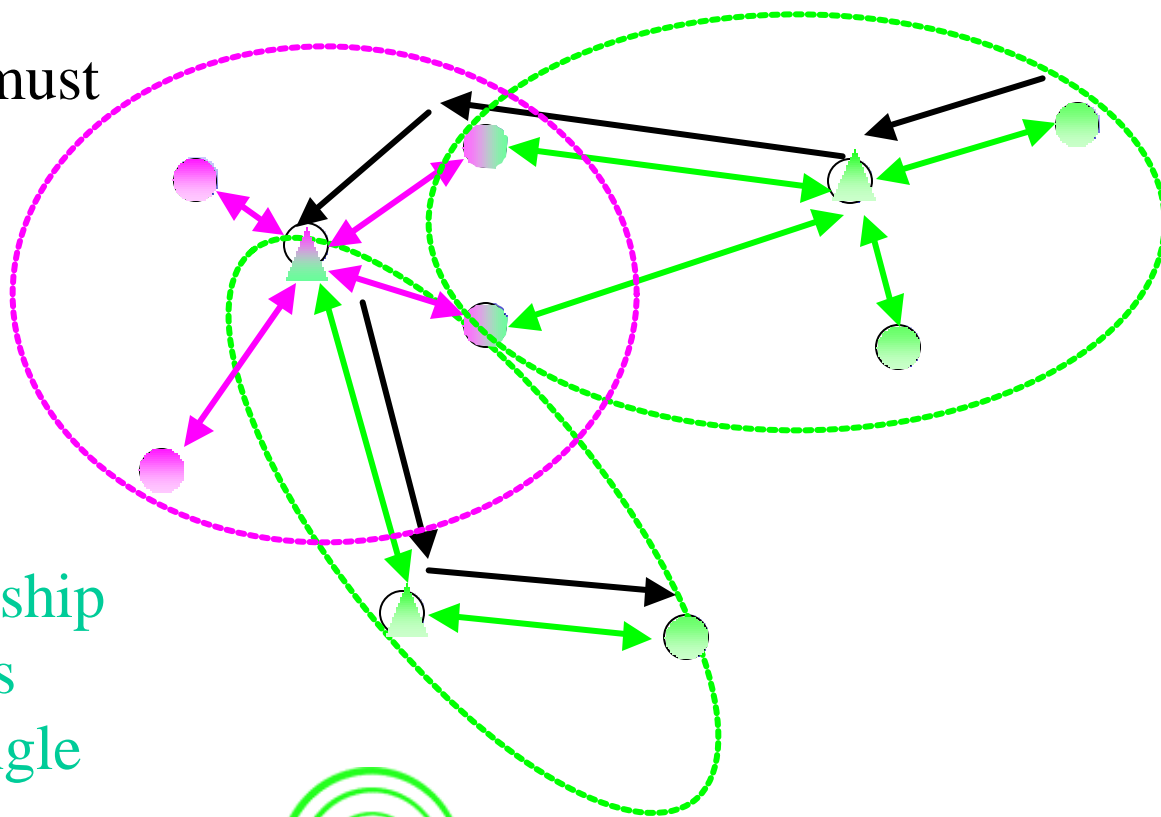




Multi-Cluster



- Multiple controllers must be assigned (elected)
- Physical connectivity must be determined
- Scalable
- Challenge:
 - establishing and maintaining membership in multiple clusters is non-trivial with a single radio.





Multi Clustering With a Single Transceiver



- Time slicing to talk on multiple clusters
 - Introduces extra delay
- In spread spectrum systems (FH/DS) code acquisition and tracking must be done for multiple clusters.
- Requires non-trivial modification of existing standard (commercial) MAC schemes





Dual Radio Design Solves the Cluster Membership Problem

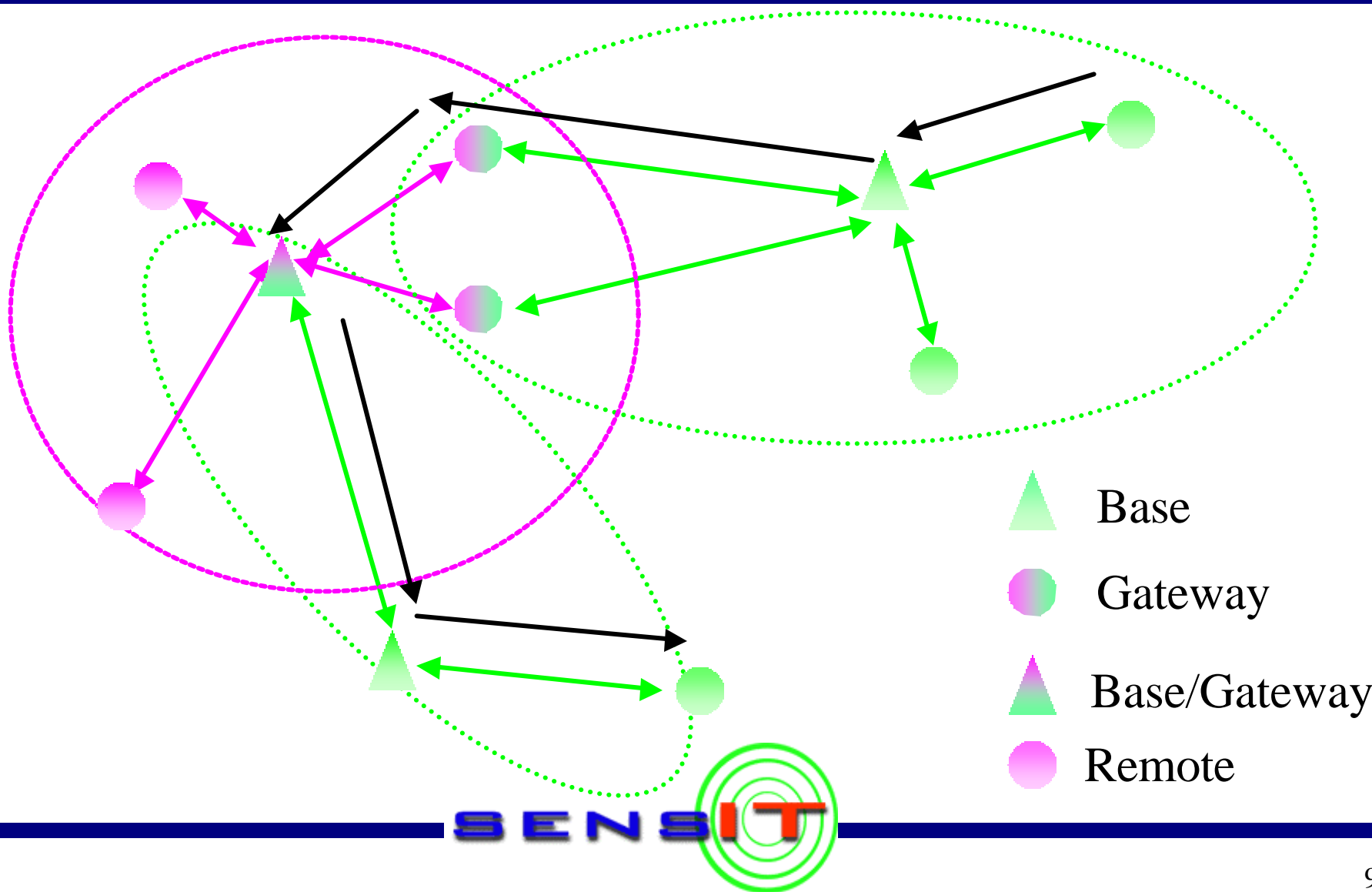


- Each node has two radio interfaces
- Each radio is capable of establishing connection(s) with other radios on a specific channel (hopping pattern)
- A radio is either a Remote or a Base on its associated channel
- A Base is able to establish connections with multiple Remotes
- A Remote only communicates with a single Base
- Each cluster corresponds to a different hopping code
- Different nodes inside a cluster are separated in time (TDMA)
- Inter-cluster communication
 - Each radio on the gateway node has membership in a single cluster
 - The node acts as a bridge between two radios, and hence two different clusters





Multi-hop Multi-Cluster

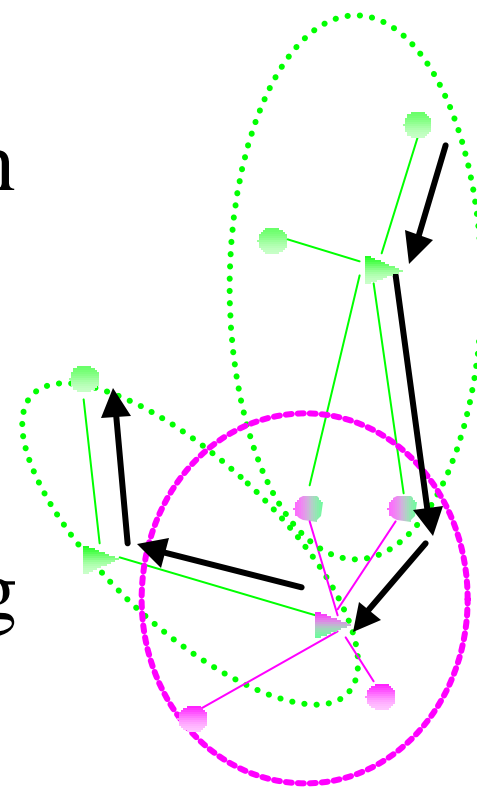




Routing



- Simple Intra-cluster routing can be achieved with minimal effort
- Routing to neighboring clusters can also easily be enabled
- For more elaborate network wide routing for specific applications users must design their own routing algorithms





Conclusion



- WINS NG 2.0 supports a multi-hop multi-cluster link layer architecture
- The link layer architecture is enabled by means of a dual radio design
- The architecture is scalable

